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CRYOGENIC GRINDING OF BLACK PEPPER IS A NOVEL APPROACH WHEREAS CONVENTIONAL GRINDING NEEDS IMPROVEMENT

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Abstract—Study on ambient and cryogenic grinding was performed to test the novelty of cryogenic grinding and pin point the drawbacks of conventional grinding. Comparative study had shown that ambient grinding need more power and specific energy than cryogenic grinding. The fat content of spices poses problems of temperature rise during grinding. Spices loose fraction of their volatile oil or flavouring components due to this temperature rise. Therefore, cooling of spices at low temperature before feeding to the grinder and maintaining the low temperature in the grinding zone can significantly retain the volatile oil or other flavouring components. Attempt is made to investigate the retention of flavouring components of spices black pepper. Liquid nitrogen used to provide refrigeration needed to precool the spices and to maintain low temperature by absorbing heat generated during the grinding operation. The colour values of cryogenic ground spices were found better than conventional ground spices. The grinding on flavoring components of black pepper under cryogenic grinding condition were found superior in quality than that of conventional grinding condition.

Keywords—conventional grinding, black pepper, colour, cryogenic grinding

I. INTRODUCTION

Spices are important agricultural commodities throughout the world due to their high unit price. This is particularly true for India which produces about 2.5 million tonnes (valued at 3 billion US$) of spices, processes, markets in domestic sector and exports them to various countries to earn a handsome foreign exchange. India's share in the world trade amounts to 46% of the total in quantity (about 30% in monitory terms) (Anon, 2001a). It is, therefore, necessary to give due attention to this commodity with particular reference to quality and value addition. Spices occupied an important place in the world trade amounting to more than half million tonnes valued at US$ 2.0 billion during 1998-1999 and with a projected quantity of about 0.6 million tonnes valued at US$ 3.0 billion in 2001. Export of spices from India during 1998-1999 was around 0.2 million tonnes valued at about Rs. 1650 crores (US$ 400 million) (Peter, 1999) and was estimated to grow to about Rs. 1860 crores (US$ 430 million) during 1999-2000 (Anon, 2001a). The demand for value added products such as volatile oils and oleoresins has also increased in the international market from 1,330 tonnes in 1998-1999 to 1,575 tonnes (valued at Rs. 159 crores) in 1999-2000 (Anon, 2001 b).

Of all the spices produced in India, black pepper (Piper nigrum L.), also called the 'King of Spices', is one of the major spices being exported amounting to more than 35,000 tonnes during 1998-1999 valued at about Rs. 650 crores (Peter, 1999) and estimated to increase to about 42,000 tonnes valued at Rs. 865 crores during 1999-2000 (Anon, 2001a). Black pepper is a common spice produced in oriental countries (mostly in south east Asia including India, Indonesia and Malaysia) but is used worldwide for its characteristic pungent flavour and taste. Piper nigrunz L., from which pepper is derived, is a perennial climbing vine or shrub. Fruits, botanically called drupes but generally called berries, are dark green turning bright orange and red when ripe, and have a thin testa. Onsun-drying, it turns greyish to dark brown colour, and hence popularly known as black pepper.

Many spices including black pepper are ground to coarse or fine particles to provide convenience to the human consumption. Further, the unit operation of grinding adds to the cost and hence becomes a process of value addition. The immediate question that arises is the quality of the ground material; a processor always tries to maintain the same quality in the finished product compared to the original sample (whole seed). It is obvious that some portion of input mechanical energy is transformed into thermal energy during grinding. The extent of transformation of mechanical energy depends on several factors including raw material attributes, type and design of grinding system, and grinding characteristics of the material. Thus, there is a need to know how these factors affect the quality and characteristics of the finished product. The other question that arises at this point is that the extent of deterioration of quality. If so, to what extent and how they are related with those above mentioned factors because quality directly affects the price. In the present era of competitive world trade, it is very important that the 'quality of the product should be of international standards. The last question that arises here is how to maintain or improve the quality of the product. Not much work has been carried out to find the answers for these

The fundamental principle of cryogenic grinding is similar to that of conventional grinding methods for materials, but the compositions are very complex, containing aromatics of high volatility, oils and fats, which are easily oxidized. Using liquid nitrogen or liquid air as the cryogen, all of thermo-sensitive herbal medicines, spices and important food commodity can be ground below their brittle temperature.

II. COMPARISON BETWEEN CONVENTIONAL AND CRYOGENIC GRINDING SYSTEM

Conventional Grinding System	Cryogenic Grinding System
• The heat developed inside the grinding mill.	• Temperature below $0^{o}c$ inside the grinding mill.
• This heat is developed during grinding, leads on the one hand to evaporation of the essential oils and on the other hand, heat sensitive fats are melted. This is turn can lead to the grinding elements become grassy (oily) and clogged or even to m/c blockages.	• Minimal loss of volatile components.
• High energy consumption.	• Low energy consumption.
• Existing grinding equipment more than two times recycle into the mill for required particle size.	• Approx. 2-3 times higher grinding capacity.
• Fire Risk.	• No fire risk.
• Air pollution due to evaporating essential oil into the atmosphere.	• No, evaporation of essential oil into the atmosphere.

III. EXPERIMENTAL SET UP

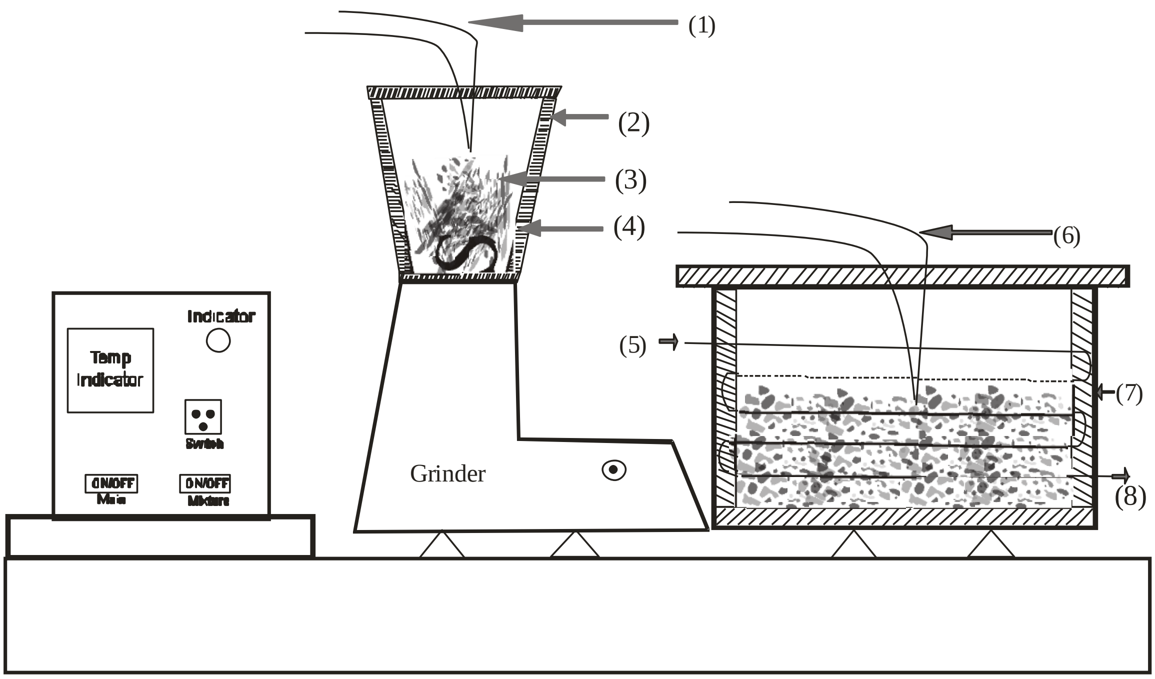

Fig. 4.1 Schematic Of Experiment Set Up

(1) Thermocouple for temperature measurement of grinding spices sample
(2) Grinding jar
(3) Spice sample
(4) Thermocole insulation
(5) Liquid Nitrogen in
(6) Thermocouples for temp. measurement before grinding of sample
(7) Thermocole Insulation
(8) Liquid Nitrogen Gas out

IV. EXPERIMENTATION

"Table1. Time temperature study of spices grinding at atmospheric temperature"

Spices	Weight (gm)	Time (sec)	Temp. before grinding, (K)	Temp. after grinding, (K)	Temp. rise (K)
Black pepper	125	165	306.4	323.6	17.2

"Table 2. Time temperature study of spices grinding at cryogenic temperature"

Spices	Weight (gm)	Time (sec)	Temperature in precooling jar (K)	Temperature In grinder before grinding (K)	Temperature in grinder after grinding (K)	Rise in temp. (K)
Black pepper	125	165	133.0	238.0	287.0	49.0

"Table 3. Moisture content for conventional and cryogrinding of spices"

Spices	Weight (gm)	Moisture content (%) for conventional grinding	Moisture content (%) for cryogrinding	% decrease
Black pepper	125	10.5	4.5	57.1

"Table 4.volatile oil content for conventional and cryogrinding of spices"

Spices	Weight (gm)	Volatile oil content (%) conventional grinding	Volatile oil content (%) cryogenic grinding	% Increase
Black pepper	125	2.4	5.6	133.3

"Table 5. Non-volatile ether extract for conventional and cryogrinding of spices"

Spices	Weight (gm)	Non-volatile ether extract (%)for conventional grinding	Non-volatile ether extract (%) for cryogrinding	% Increase
Black pep|	125	9.61	30.8	220.0

V. RESULT AND DISCUSSION

Comparision of the quality and flavour of spices in conventional and cryogenic grinding is done. Experimentation carried out on , black pepper . Testing of the spice sample carried out in the central agmark laboratory and premier agmark laboratory. Quality characteristics of various sample found out by considering following properties.

- Moisture %
- Volatile oil %
- Non volatile ether extract %
- Piprine Content %

black pepper shows the moisture content decrease by 57.1%, Volatile oil content is increased by 57.14%, Non-volatile ether extract is increased by 68.79% ,piprine content is increased by 42.11% compared to conventional grinding.

VI. CONCLUSION

- In cryogenic grinding system Moisture % should be decreases, volatile oil, Non volatile ether extract, piprine content and curcuminoid % should be increases.
- From this we concluded that quality and flavour can be achieved in cryogenic grinding system as compared to conventional grinding system.

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